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MONTHLY PROGRESS REPORT

PULSE-SENSITIVE ELECTROEXPLOSIVE DEVICES

February 1963

0689-01(08)MP

Contract N178-8107

401 479

ORDNANCE DIVISION

Aerojet-General

CORPORATION

A SUBSIDIARY OF THE GENERAL TIRE & RUBBER COMPANY
AZUSA, SACRAMENTO, AND DOWNEY, CALIFORNIA

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ILLUSTRATIONS

1. INTRODUCTION

This is the eighth monthly progress report of the program to study the behavior of electrically pulsed metal films on substrates of high thermal conductivity (Reference 1). Phase I is the feasibility and process development study.

2. OBJECT

The purpose of this program is to investigate the behavior of a metallic film when it is electrically heated and is in physical contact with a heat sink. Specifically, the aim is to study the variable parameters and to develop a manufacturing process or processes for applying a bridge heating element to a ceramic surface with the required thermal contact.

3. WORK PERFORMED DURING FEBRUARY

3.1 TEST EQUIPMENT

Delivery of the Beryllium Oxide (BeO) header units has been further delayed. These units, originally expected in December 1962, are now to be delivered during the week of 4 March 1963.

The tools for explosive loading of the test units were completed and used to load glass header units with polyvinylalcohol (PVA) lead azide conforming to MIL Specification, MIL-L-3055. Test firings performed with glass headers indicate that BeO dust will result from test firings of BeO headers. Figure 1 shows the amount of glass header damage experienced when 10 mg of lead azide press loaded at 5000 psi are fired. Plans are being formulated to protect personnel from the toxic effects of airborne BeO dust particles. An existing firing chamber is being modified to include an adequate filter system. To confine the BeO dust and particles, the units will be fired within a stainless steel pressure cooker inside the firing chamber. Cable connector feed-through terminals and a valve to relieve pressure prior to lid removal after firing have been installed in the lid of the pressure cooker. Figure 2 shows the top and Figure 3 the inside of the modified pressure cooker. Because the walls and particularly the lid of the pressure cooker are thin, additional aluminum baffles are incorporated to stop fragments.

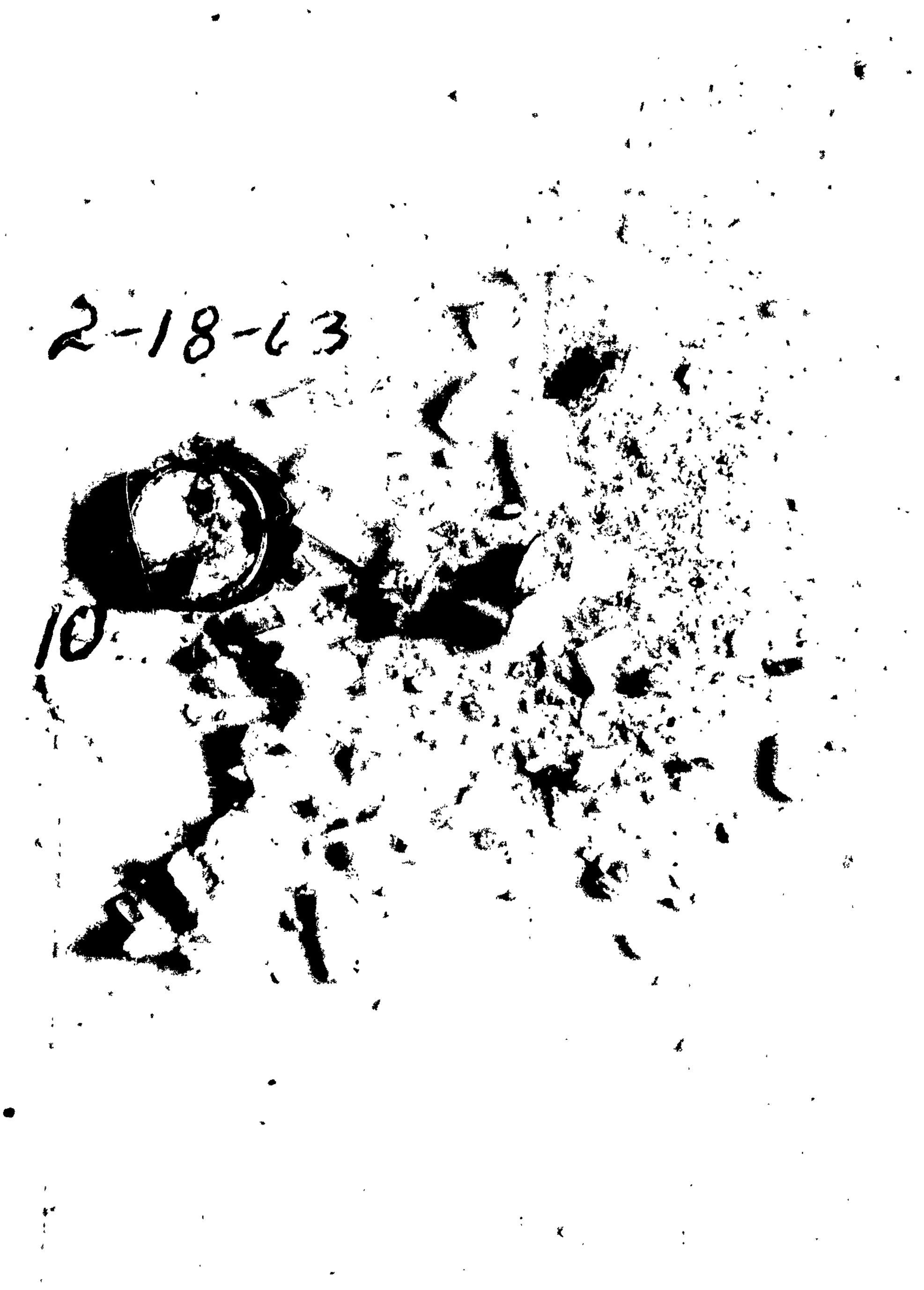

Figure 1. Glass Header Damage Experienced when 10 mg of Lead Azide are Fired.

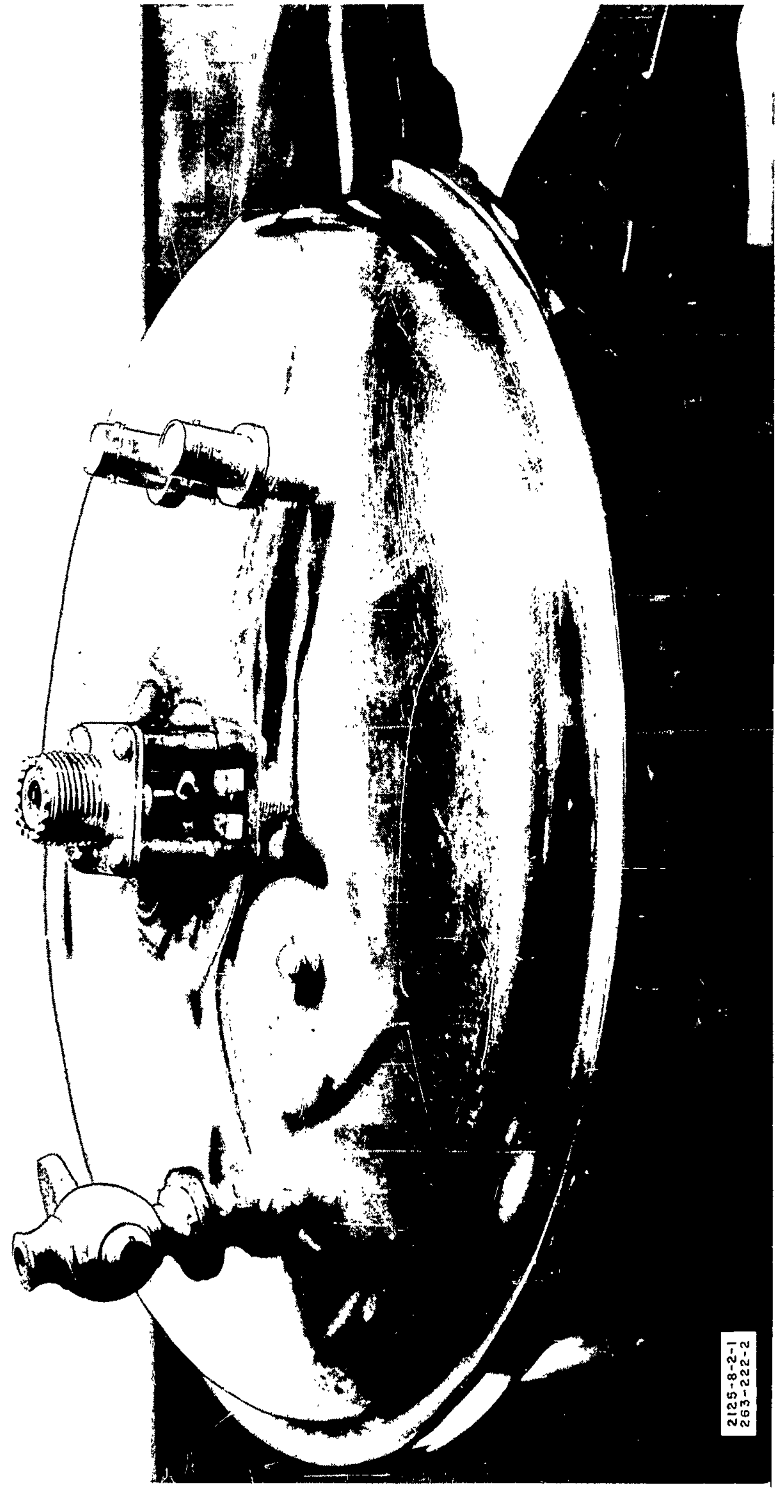

Figure 2. Top of Modified Pressure Cooker.

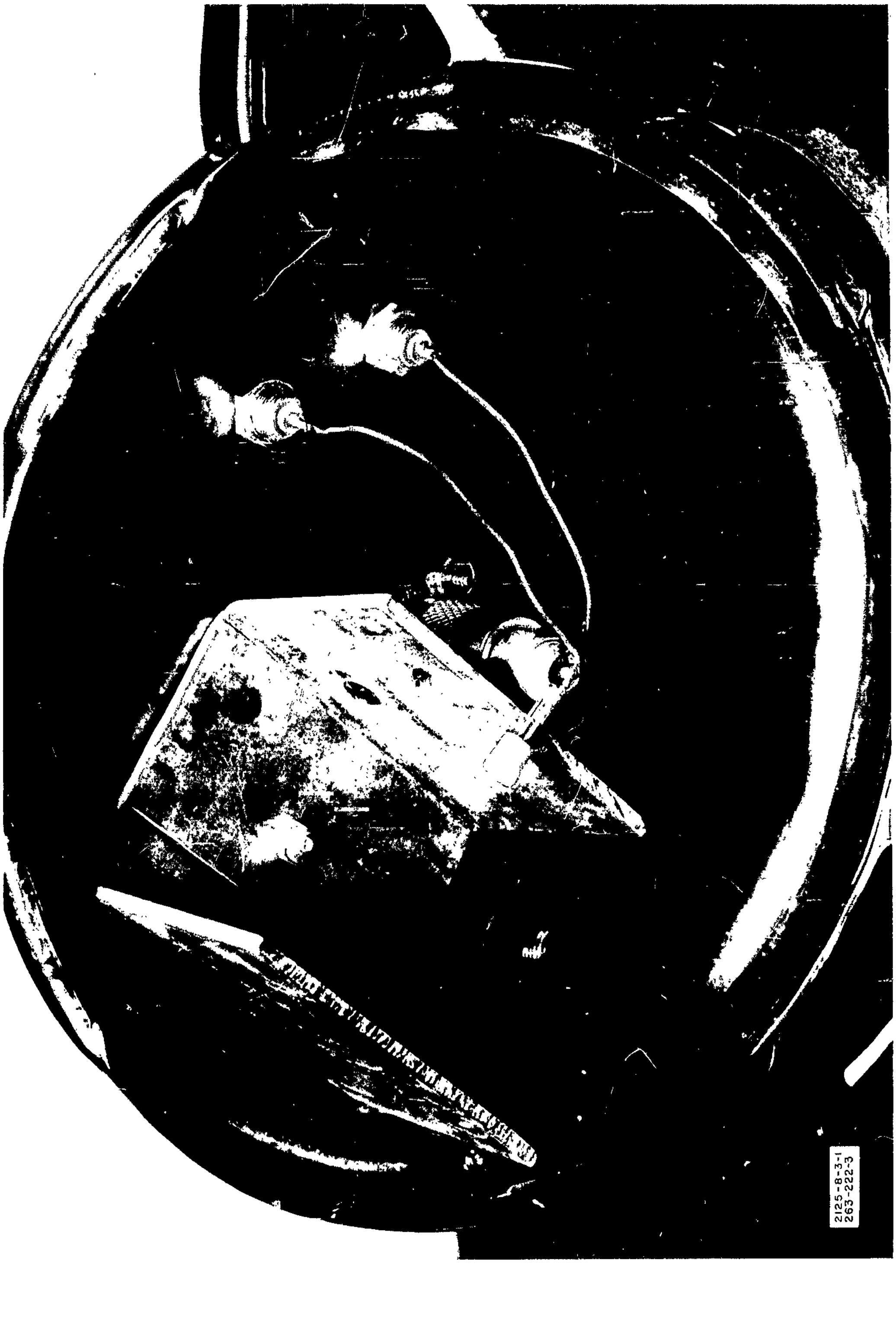

Figure 3. Inside of the Modified Pressure Cooker.

3.2 FILM DEPOSITION

An improved header holding fixture has been designed for film depositions and is being made. No film depositions have been done this month, pending receipt of BeO headers.

3.3 TESTING

Tests this month consisted of both steady and pulsed current heating of gold film and Pt/Ir (90/10) 2 mil wire bridges on the glass headers. Some of these tests were conducted with 10 mg of PVA lead azide press loaded at 5000 psi into a nylon charge holder. The nylon charge holder was cemented onto the glass header with Eastman 910 adhesive. Figure 4 (top) shows a glass header and charge holder assembled before loading with explosive. Figure 4 (bottom) is a photomicrograph of the gold film bridge. The data for the pulse heating tests with explosive loaded units are presented in Tables 1 and 2, and for the steady current tests in Tables 3 and 4.

The heating pulse for the pulse tests was obtained from the discharge of a 1μ fd capacitor across the bridge. The voltage levels of the charged capacitor for ignition are indicated in the tables. The units were pulsed with successively higher capacitor voltage until explosive ignition occurred. With the wire bridges a pin switch was necessary to determine time of ignition. Figure 5 shows an oscilloscope time trace for one of the test firings of a film bridge unit.

The steady current tests were conducted by establishing an initial current level from a 12 v storage battery and series resistors while the terminals were shorted with an iron wire shunt. The battery voltage was removed and the shunt then replaced with the header unit. If the unit did not ignite the explosive within a minute after the current was applied, the current level was gradually raised until ignition occurred. The current levels at ignition are presented in Tables 3 and 4.

A slightly higher steady current level is necessary for ignition with the film bridged units than with the wire bridge units. However, for ignition by the 1μ fd capacitor discharge pulse, less than half the capacitor voltage is required for the film bridge units than is required for the wire bridge units. The film bridge is thus more sensitive to pulse firing than the wire bridge. Bruceton no-fire tests would be of interest for comparative evaluation.

Table 1. Gold Film Pulse Tests.

Sample No.	Film Width (mils)	Time (μ f)	Peak Current (amp)	Capacitor Voltage (v)	Initial Resistance (ohms)
13-G	73	1.8	70	100	0.188
11-G	73	1.1	58	86	----
17-G	74	0.8	50	95	0.176
18-G	73	0.6	45	86	0.168
10-G	66	1.8	52	86	0.175

Table 2. Pt/Ir 90/10 2 Mil BW Pulse Tests.

Sample No.	Time (μ f)	Peak Current (amp)	Capacitor Voltage (v)	Initial Resistance (ohms)
1-W		200	260	0.174
2-W		175	240	0.174
3-W		175	240	0.185
4-W		175	240	0.183
5-W		175	240	0.185
6-W		--	300	0.177
7-W	2.4	235	300	0.182
4-w	13.2	180	240	0.173
6-w	4.0	185	255	0.155
7-w	5.0	180	238	0.163

Table 3. Gold Film Steady Current Tests.

Sample No.	Film Width (mils)	Current at Ignition (amp)	Initial Resistance (ohms)
14-G	65	2.5	0.206
12-G	74	2.5	0.216
16-G	74	2.6	0.176

Table 4. 90/10 Pt/Ir 2 Mil BW Steady Current Tests.

Sample No.	Current At Ignition (amp)	Initial Resistance (ohms)	Comments
5-w	2.2	0.175	1.5 amp raised to 2.1 amp to fire
8-W	2.1	0.165	Fired on closing switch
9-W	2.02	0.185	Fired on Closing switch
10-W	2.15	0.164	1.7 amp raised to 2.15 amp

TOP

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Figure 4. Sample 10-G Bridged Glass Header and Nylon Charge Holder.

BOTTOM

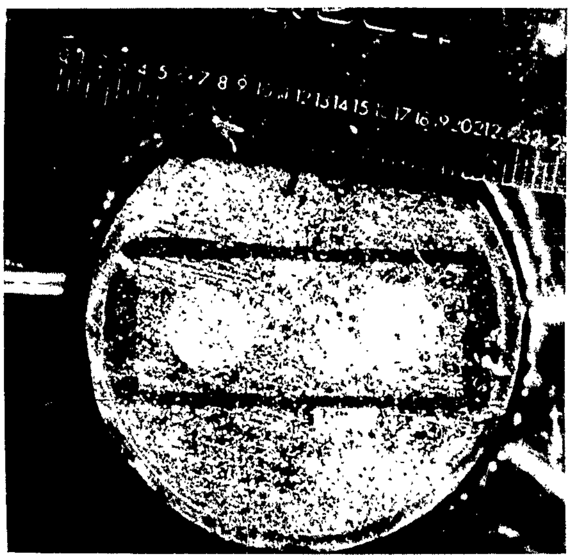

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Figure 4. Sample 10-G Gold Film Bridge on Glass Header.
(1 div = 0. 005 in.)

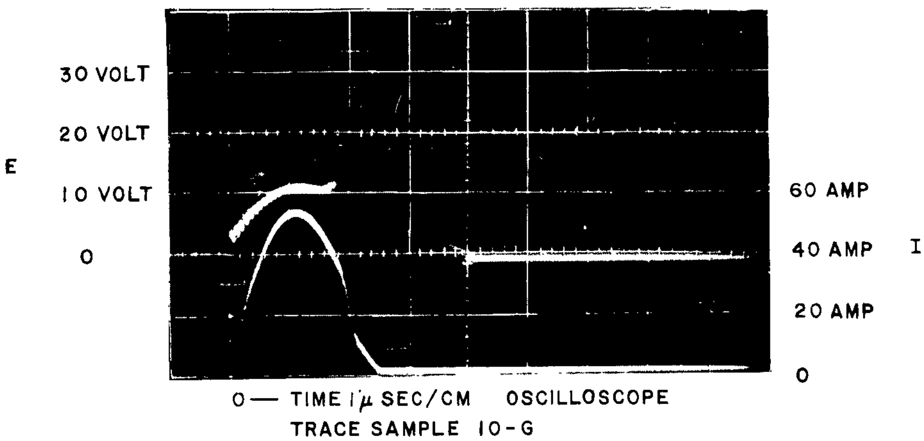

Figure 5. Oscilloscope Time Trace for One of the Test Firings of a Film Bridge Unit.

(Upper Trace Represents Voltage; Lower Trace Represents Current)

4. WORK PLANNED FOR NEXT MONTH

a. Prepare test chamber and filter system for BeO explosive tests.

b. Deposit gold films on BeO headers.

c. Conduct pulse and steady current tests with BeO headers.

REFERENCES

1. U.S. Naval Weapons Laboratory, Contract N178-8107, dated 30 June 1962.